In Part IV. the author relates a few very general conclusions that he has arrived at after his series of visits, some of which we will state quite briefly. Each prominent instrument should have its own building; dwellings for observers should be on the premises; good workshops should be provided, so that repairs may be done on the spot; and electricity should be used throughout. Copies of the orders from the Navy Department follow next in order; and the volume terminates with a list of books, photographs, &c., that were bought at the various places visited.

The work as a whole supplies the reader with an excellent and trustworthy description of many of the chief Observatories of the present day; it may be stated, however, that the author has deemed it necessary to omit a large amount of information on methods, instruments, &c., his reason for so doing being that it will be found in other publications.

The illustrations throughout add greatly to the value of the book, and the American Government ought to be congratulated on the result of the work.

FIELD EXPERIMENTS AT ROTHAMSTED.[1]

THESE memoranda are issued yearly, in order to bring the results of the field experiments up to the present time. The matter is closely condensed, most of the information being in the form of schedules and tables. The results include observations and experiments upon rainfall, drainage, composition of drainage water, disposal of rainfall through percolation and evaporation, as well as upon the effects of artificial manures on various crops, most of which have been grown upon the same land, under strictly regulated conditions, for forty years. To those who are accustomed to follow the results obtained at Rothamsted, there is nothing novel in those portions of the memoranda, as they merely contain the account of a work with which the agricultural public is familiar. No one not already aware of the elaborate nature of the Rothamsted experiments can take up these memoranda without being struck with the vast amount of labour, patience, expenditure, and ability disclosed. Agriculturists will probably be disposed to confine their attention to the effects of fertilizers upon certain crops, but after perusing this interesting document we come to the conclusion that the Rothamsted observations reach much further in their significance than the limits of agricultural practice. They must assist in the solution of physiological questions involving both animals and vegetables, and physical questions relating to the gradual changes wrought upon the surface of the earth through rainfall and atmospheric action. The Rothamsted results, carefully tabulated year by year, contain a mass of data from which important conclusions may be drawn. Among these data we note—(1) Observations upon the determination of nitrogen as ammonia, as nitric acid, and as organic nitrogen, and also some other constituents, in many samples both of the rain and of the various drainage waters collected at Rothamsted. It is only by such observations that any idea can be formed as to the sources of the nitrogen of growing plants. We have here a means for estimating both the amount of nitrogen brought down in rain and wasted through drainage—two factors which must be kept in view when the relations of plants to combined nitrogen at present existing in the soil are to be investigated. (2) Observations on the difference in the character and amount of the constituents assimilated by plants of different botanical relationships, under equal external conditions, or by the same description of plants under varying conditions. (3) Observations on the character and range of the roots of different plants, and on their relative development of stem, leaf, &c. (4) Observations on the composition of the entire plant, and various parts of the same plants, at different stages of growth.

One of the most important subjects, which has acquired fresh interest at the present time, is that of the assimilation of free nitrogen by growing plants. In treating of this deeply interesting question Sir John Lawes says:—"In recent years this question has assumed quite a new aspect. It now is, whether the free nitrogen of the atmosphere is brought into combination under the influence of micro-organisms or other low forms, either within the soil or in symbiosis with a higher plant, thus serving indirectly as a source of nitrogen to plants of a higher order. Considering that the results of Hellriegel and Wilfarth on this point were, if confirmed, of great significance and importance, . . . a preliminary series (of experiments) was undertaken in 1888, a more extended one was conducted in 1889, and the subject is being further investigated in the present year. The results so far obtained show that, when a soil growing leguminous plants is infected with appropriate organisms, there is a development of the so-called leguminous nodules on the roots of the plants, and, coincidently, increased growth and gain of nitrogen. These results were obtained after adding to a sterilized sandy soil growing leguminous plants a small quantity of the watery extract of a soil containing the appropriate organisms. There is no evidence that the leguminous plant itself assimilates free nitrogen; the supposition is rather that the gain is due to the fixation of nitrogen in the growth of the lower organisms in the root nodules, the nitrogenous compounds so produced being taken up and utilized by the leguminous plants. It would seem, therefore, that in the growth of leguminous plants, such as clover, vetches, peas, beans, lucerne, &c., at any rate some of the large amount of nitrogen which they contain may be due to atmospheric nitrogen brought into combination by the agency of lower organisms." No hint is given as to the identity of the "lower organism" so frequently mentioned, but there is reason to think that it is a fungus belonging to the class *Ustilagineæ*, which exists in and is the cause of the tubercles, or root nodules, found upon the root fibres of leguminous plants.

The bulk of the memorandum is occupied with the continuation and re-editing up to date of the results obtained at Rothamsted by the application of fertilizers. The matter is important, but as it takes the form of an annual report in which the latest results are added to and incorporated with those of previous years, already noticed by us in due course, we must refrain at the present time from more lengthy notice. Sir John Lawes has always been a stout advocate of the view that the source of nitrogen in plants was to be looked for *in the soil* and not in the air. It is, therefore, an interesting fact, as between him and the believers in the assimilation of atmospheric free nitrogen, that the micro-organisms in question seem to offer a *modus vivendi*, or means of reconciliation, between two hitherto conflicting doctrines.

SCIENTIFIC SERIALS.

IN the *American Meteorological Journal* for November, Prof. W. Ferrel replies to the attacks made by Prof. Hazen on Espy's experiments on storm generation. He points out that this theory does not rest upon the experiments of Espy alone, but on those of Regnault, Clausius, Sir W. Thomson, and others, all of which were finally embraced in a convenient formula by Dr. Hann, and adopted by himself (*Meteor. Zeitsch.*, 1874, and Smithsonian Report, 1877). M. H. Faye continues his articles on the "Accessory Phenomena of Cyclones." This number also contains a summary of a report by Mr. W. Ogilvie on his exploration of the Canadian Yukon, and the region between it and the Mackenzie, in 1887 and 1888, embracing some portions of country never before visited by a white man. He wintered in 1887 in lat. 64° 61′, long. 140° 54′. The maximum pressure in January reached 30·3 inches or 0·3 inch higher than the most trustworthy maximum isobars for that region. The mean minimum temperature in December was − 33°·6, and the absolute minimum in the same month − 55°·1. The mean temperature is not given. Drifting ice in the river commenced on October 21, the ice set on November 15, and on February 3 the thickness amounted to 48 inches. From the station on the Yukon to one on the Porcupine, lat. 65° 43′ long., 139° 43′, the following meteorological notes are given: lowest temperature in April, − 37°. The last time a minus reading was recorded was May 5, − 1°·8. Highest temperature in April, 40° on 30th; the highest in May, 55° on 7th. The report contains a series of notes on the opening and closing of the Mackenzie, on the duration of sunlight, and on the climate and capabilities of that region. Green clouds, a phenomenon apparently rare, were observed on the mornings of February 19 and 29 just before sunrise; at the same time there was a slight fall of minute ice-crystals.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 11.—"On Ellipsoidal Harmonics." By W. D. Niven, F.R.S.

In this paper some of the properties of these functions are obtained from a discussion of their expressions in Cartesian co-ordinates.

---

[1] "Memoranda of Field Experiments at Rothamsted, Herts, conducted by Sir John Lawes, Bart." 1890.

If Θ_r denote

$$\frac{x^2}{a^2+\theta_r}+\frac{y^2}{b^2+\theta_r}+\frac{z^2}{c^2+\theta_r}-1,$$

the general expression for an ellipsoidal harmonic is given by

$$G=(1,\ x, y, z, yz,\ zx,\ xy,\ xyz)\Theta_1\ldots\Theta_n,$$

where any of the quantities inside the brackets is the multiplier of the product of Θ's outside, provided n equations of the form

$$\frac{p}{a^2+\theta_1}+\frac{q}{b^2+\theta_1}+\frac{r}{c^2+\theta_1}+\frac{4}{\theta_1-\theta_2}+\ldots+\frac{4}{\theta_1-\theta_n}=0$$

are satisfied, p, q, r being respectively 3 or 1, according as G does or does not contain x, y, z as factors.

For the same values of θ, another function satisfies Laplace's equation, given by

$$H=(1,\ x,\ y,\ z,\ yz,\ zx,\ xy,\ xyz)K_1\ldots K_n,$$

where

$$K_r-1=\Theta_r.$$

The functions (H) are spherical harmonics, and several properties of the functions (G) depend upon those of (H).

The functions (G) are applicable to the interior of the ellipsoid. Those pertaining to the exterior, as is well known, are of the form GI, where I is a certain integral depending on the quantities θ pertaining to G.

If G and H are corresponding functions of the nth degree according to the above definitions, then

$$GI=(-1)^n\frac{1}{2^n n!}H\left(\frac{d}{dx},\ \frac{d}{dy},\ \frac{d}{dz}\right)V_n,$$

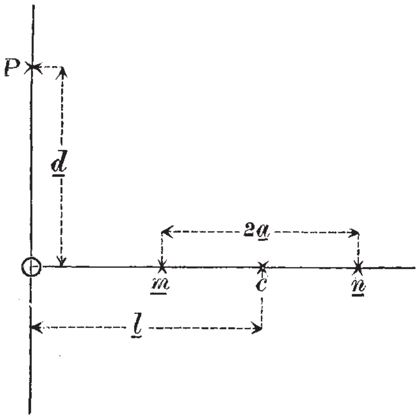
where V_n is the potential at xyz due to an ellipsoid whose density at any internal point f, g, h is

$$n\left(1-\frac{f^2}{a^2}-\frac{g^2}{b^2}-\frac{h^2}{c^2}\right)^{n-1}.$$

The remainder of the paper is occupied with the reduction and application of these results to ellipsoids of revolution.

Physical Society, November 28.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—The following communications were made:—Additional notes on secondary batteries, by Dr. J. H. Gladstone, F.R.S., and Mr. W. Hibbert. After referring to the debatable points as to what compounds are formed and decomposed in the working of such batteries, the authors give the results of their examination of the red substance formed by the action of dilute sulphuric acid on minium, and which Dr. Frankland believes to be a compound having the formula $Pb_3S_2O_{10}$. The ultimate analysis showed 72 per cent. of lead. A portion of the substance was treated with a 3 per cent. solution of ammonium acetate to dissolve out any normal sulphate that might be present; this left a residue much darker in colour than the original substance, and containing 82 per cent. of lead. PbO_2 contains 86·6 per cent. of lead. The colourless solution yielded a ratio of Pb to SO_4, varying from 2·0 to 2·15; pure $PbSO_4$ requires a ratio of 2·16, and Frankland's compound 3·23. From these results the authors conclude that the portion dissolved was not a basic sulphate, and that the evidence tells against the original substance being a chemical compound. The authors have also continued their comparative experiments on the action of spongy lead on dilute sulphuric acid, either pure, or containing a small quantity of sulphate of soda. After the experiments had gone on for five months, the residues were analyzed; that from the pure acid showed 82 per cent. of lead sulphate and 18 per cent. of metallic lead, whilst that mixed with sodium sulphate gave 89 per cent. of lead sulphate and 11 per cent. of lead. They therefore conclude that although the action of acid on lead is initially diminished by the presence of sodium sulphate, the final result is rather the other way. Mr. G. H. Robertson, who had used ammonium acetate to analyze plugs from storage cells, said he had arrived at results much the same as those stated by the authors. Mr. Swinburne said Dr. Frankland was absent, but, without agreeing with him, he would suggest that Dr. Frankland might say that ammonium acetate decomposed the subsalt $Pb_3S_2O_{10}$, and then dissolved the sulphate $PbSO_4$. The question might be attacked by acting on equal quantities of the substance and the mixture PbO_2, $2PbSO_4$, in a calorimeter with ammonium acetate, to see if the same heat is produced; this would show whether the substance is a mixture or a compound.

Dr. S. P. Thompson was glad that the authors allowed a possibility of basic sulphate being formed, for it was well known that an almost irreducible sulphate resulted from leaving a cell nearly discharged; this, he thought, would point to a possible formation of a basic sulphate from PbO and $PbSO_4$. Mr. Swinburne did not see where the PbO came from, except in newly pasted negatives, and he knew of no evidence of an intermediate stage of oxide on the plates. They appear to change directly to sulphate. Dr. Thompson said that a rapid discharge was known to produce basic salts. This, Mr. Swinburne thought due to deficiency of acid near the plates. Peroxide, he said, could not be formed on the negative, without the acid was heterogeneous and gave rise to local currents. Mr. W. Hibbert, referring to Mr. Swinburne's statement, said he had put one plate of spongy lead into strong acid and another into weak, and from this arrangement obtained a fairly large current. As regards the basic sulphate spoken of by Dr. Thompson, he did not think there was much probability of its being formed. Time, he said, had an important influence on a partially discharged cell, and he would not expect to easily reduce the $PbSO_4$ formed by the long-continued action of lead on sulphuric acid. The President inquired whether Mr. Hibbert's argument would apply to a fully charged cell. Mr. Hibbert, in reply, said that in this case the time required to produce sufficient sulphate to be irreducible would be very much longer, for in a partially discharged cell much sulphate was already formed. Dr. Gladstone said he had anticipated that Dr. Frankland would raise the objection referred to by Mr. Swinburne. As far as he was aware, there was no direct evidence either way, but he thought that the suggested decomposition was improbable. If he acted on a mixture of PbO_2 and $PbSO_4$, he would expect to get the results actually obtained. Mixtures, however, were difficult to deal with, and the results not conclusive, for the physical condition of the mixture was not the same as that of the actual products. Referring to Dr. Thompson's remarks, he understood that it was the basic sulphate which he (Dr. Thompson) considered irreducible. Dr. Frankland, however, believed this sulphate more easily reduced than $PbSO_4$. The President remarked that he thought Dr. Frankland had two reasons for his belief in the existence of the basic sulphates. One of these was the difficulty in reducing normal sulphate, whilst the other was based on the rapid fall of E.M.F. at a certain part of the discharge. It was at this point that Dr. Frankland thought the new sulphate formed, and to meet this argument it was necessary to find some other explanation of the rapid fall. In this connection he (the President) inquired whether there was sufficient peroxide formed on the negative plate to account for the drop. On this point Dr. Gladstone could not speak decisively.—An illustration of Ewing's theory of magnetism, by Prof. S. P. Thompson. A number of small "charm" compasses were placed together on a glass plate of an ordinary vertical attachment to a lantern. A large magnet at a distance served to neutralize the earth's field, and a coil enabled a magnetizing force to be applied in the plane of the needles. By this apparatus all the various phenomena exhibited by Ewing's model were beautifully shown on a screen. In the course of his experiments Dr. Thompson had found that when small magnets placed at moderate distances apart were used, it was much more necessary to neutralize the earth's field, in order that they might set themselves according to their mutual attractions, than when larger magnets were employed. A weak field directed the small openly spaced magnets, whereas with larger ones, their mutual actions were much more powerful. This fact may, he thought, throw some light on the molecular groupings in magnetite (loadstone). This substance exists in two forms, viz. one crystalline and the other of a heterogeneous structure. The former variety exhibits no magnetic retentiveness, whilst the latter is decidedly magnetic. As far as he was aware, no sufficient explanation had been given of the non-retentiveness of the crystalline variety. A difference in the molecular distances or groupings might account for the peculiarity. Mr. Boys said it was rather curious that Prof. Rücker had just devised a somewhat similar illustration of Ewing's theory, and he exhibited it at the meeting. It consists of little magnets made of long U-shaped pieces of watch-spring pivoted by glass caps on needle-points; the needle-points are fixed in little disks of lead stuck on a sheet of glass which forms the base of a glass box. An open helix surrounding the box serves to apply magnetic force. Mr. Swinburne called attention to two theoretical points. First as regards susceptibility (which he regarded as a mere ratio and not a property), he said that if particles of iron at a high temperature rotate, as has been supposed, the susceptibility should be negative, and Prof. Ewing had some reason to think that this was the case. The next point concerned the loss of energy when an armature rotates in a strong magnetic field; this, he said, was known to be considerable, whereas if Ewing's theory is correct he would expect little or no loss, for all the little magnets would always put themselves in the direction of the field, and would never pass through positions of unstable equilibrium. The President said he had discussed the question of negative susceptibility some years ago with Dr. Lodge, with reference to the drop in the characteristics of dynamos, but he was not aware that any direct evidence had been obtained. Prof. Perry thought negative susceptibility might be possible in strong fields but not in weak ones. Mr. Swinburne, on the contrary, considered its existence would be more marked in weak fields. Mr. H. Tomlinson said he had tried experimentally whether the susceptibility of nickel, when heated above its critical temperature, was negative, but he had not been able to detect it, although his apparatus was very sensitive.—The solution of a geometrical problem in magnetism, by Thomas H. Blakesley. The problem referred to was the following: Given the two poles of a magnet and a straight line intersecting at right angles, its axis produced, to determine at what point this line is parallel to the field. The question is of scientific interest, because, if the point be found experimentally, the distance between the virtual poles of the magnet can be determined, whilst it is important practically from its bearing on the deviation of ships' compasses in certain cases. The instances in which it would apply are pointed out in the paper. Assuming the points m and n (see diagram) to be the positions of the virtual poles, and P the required point, it is shown that



$$\frac{m}{(d^2+m^2)^{\frac{3}{2}}} = \frac{n}{(d^2+n^2)^{\frac{3}{2}}},$$

where

$$Om = m, \quad On = n, \quad \text{and } OP = d.$$

From this the expression

$$\left(\frac{d^2}{2mn}\right)^3 - \frac{3}{4}\frac{d^2}{2mn} - \frac{1}{4}\frac{m^2+n^2}{2mn} = 0,$$

is deduced. Now, in hyperbolic trigonometry, we have a formula

$$\cosh^3\theta - \tfrac{3}{4}\cosh\theta - \tfrac{1}{4}\cosh 3\theta = 0,$$

hence making

$$\frac{m^2+n^2}{2mn} = \cosh 3\theta;$$

we have also

$$\frac{d^2}{2mn} = \cosh\theta.$$

The value of θ can be then found by aid of the tables of hyperbolic sines and cosines compiled by the author, and published recently by the Society. The distance d can thus be determined in terms of m and n. A method of finding the point experimentally is then described, and the distance between the poles ($2a$) shown to be given by the expression

$$\frac{a}{l} = \tanh\frac{3\theta}{2},$$

where

$$\frac{l}{d} = \sqrt{\frac{\cosh 3\theta + 1}{4\cosh\theta}},$$

l being the distance Oc. The latter function can be deduced from the tables already referred to. Experiment shows that the distance between the virtual poles soon approaches the length of the magnet, as d increases. The strength of the field at P is given by the expression

$$\frac{4M}{d^3}\frac{\cosh^2\theta}{4\cosh^2\theta - 1}$$

where M is the moment of the magnet. This can be simplified by arranging d and l so that

$$\cosh^2\theta = \frac{5}{4},$$

and then becomes

$$\frac{5}{8}\frac{M}{d^3}.$$

Under these conditions

$$\frac{l}{d} = 0{\cdot}85065,$$

and therefore the angle

$$OCP = 40^\circ\ 23'\ 10''.$$

Entomological Society, December 3.—The Right Hon. Lord Walsingham, F.R.S., President, in the chair.—Dr. D. Sharp, F.R.S., exhibited specimens of *Papilio polites*, *P. erithonius*, and *Euplœa asela*, received from Mr. J. J. Lister, who had caught them on board ship when near Colombo, in November 1888. Dr. Sharp read a letter from Mr. Lister, in which it was stated that from the ship hundreds of these butterflies were seen flying out to sea against a slight breeze. Many of them, apparently exhausted by a long flight, alighted on the deck of the ship, and large numbers perished in the sea.—Lord Walsingham exhibited a coloured drawing of a variety of *Acherontia atropos*, which had been sent to him by Mons. Henri de la Cuisine, of Dijon. He also exhibited specimens of an entomogenous fungus, apparently belonging to the genus *Torrubia*, growing on pupæ (received from Sir Charles Forbes), which had been collected in Mexico by Mr. H. B. James. Mr. McLachlan, F.R.S., expressed an opinion, in which Mr. C. O. Waterhouse and Mr. G. C. Champion concurred, that the pupæ were those of a species of *Cicada*. Mr. F. D. Godman, F.R.S., said that at the meeting of the Society on October 3, 1888, he had exhibited a larva of a *Cicada* with a similar fungoid growth.—Mr. R. Adkin exhibited male specimens of *Spilosoma mendica*, Clk., bred from ova obtained from a female of the Irish form which had been impregnated by a male of the English form. These specimens were of a dusky white colour, and were intermediate between the English and Irish forms.—Mr. R. W. Lloyd exhibited specimens of *Anisotoma Triepkei*, Schmidt, and *Megacronus inclinans*, Er., collected last August at Loch Alvie by Aviemore.—Mr. Merrifield read a paper entitled, "On the conspicuous changes in the markings and colouring of Lepidoptera caused by subjecting the pupæ to different temperature conditions," in which it was stated that the results of many experiments made on *Selenia illustraria* and *Ennomos autumnaria* tended to prove that both the markings and colouring of the moth were materially affected by the temperature to which the pupa was exposed: the markings, by long-continued exposure before the last active changes; the colouring, chiefly by exposure during these last changes, but before the colouring of the perfect insect began to be visible, a moderately low temperature during this period causing darkness, a high one producing the opposite effect, and two or three days at the right time appearing in some cases sufficient. Dryness or moisture applied during the whole pupal period had little or no effect on either markings or colouring. Mr. Merrifield said he had obtained from summer pupæ of *illustraria* some moths with summer colouring and spring markings, some with spring markings and spring colouring, and some with summer markings, but an approach to spring colouring. These specimens, with enlarged and coloured photographs of them were exhibited. Mr. C. Fenn, who said he did not agree with Mr. Merrifield's conclusions, exhibited a very long and varied series of *Ennomos autumnaria*, all of which, he stated, had been bred at the same temperature. He expressed an opinion that the presence or absence of moisture, rather than differences of temperature, was one of the principal causes of variation. The discussion was continued by Lord Walsingham, Colonel Swinhoe, Mr. Waterhouse, Mr. Jenner-Weir, Captain Elwes, Mr. McLachlan, Mr. Porritt, Dr. Mason, Mr. Goss, and Mr. Barrett.—Mr. G. T. Baker read a paper entitled "Notes on the Lepidoptera collected in Madeira by the late T. Vernon-Wollaston." The paper was illustrated by a number of figures drawn and coloured some years ago by Prof. Westwood.—Mr. Hamilton H. Druce exhibited several very beautiful species of butterflies, belonging to the genus *Hypochrysops* from the Solomon Islands and Australia, and read a paper on them, entitled "A monograph of the Lycænoid genus *Hypochrysops*, with descriptions of new species."—Mr. C. J. Gahan read a paper entitled "Notes on some species of *Diabrotica*."

Linnean Society, December 4.—Prof. Stewart, President, in the chair.—The President exhibited some eggs of the shell slug, *Testacella haliotidea*, and briefly described the habits and mode of feeding of this mollusk. He also delineated and described the feeding tract of the snail.—Mr. F. J. George exhibited an autumnal flowering form of *Mercurialis perennis*, with stems four feet in length, which he had found at Preston, Lancashire.—Mr. R. A. Rolfe exhibited and made some remarks on a coloured drawing of *Cycnoches Rossianum*, showing both male and female inflorescences on the same pseudo bulb.—Mr. J. E. Harting exhibited an immature example of Bonaparte's gull, *Larus philadelphia*, Ord, of North America, which had been shot on the Cornish coast at Newlyn on October 24 last.—Mr. T. Christy exhibited and made remarks on some coca-leaves which had been forwarded from an East Indian plantation, and which were found to be superior to any received from South America.—On behalf of Mr. H. N. Ridley, of the Botanic Gardens at Singapore, Mr. B. D. Jackson read a paper on orchids, genus *Bromheadia*, on which some critical remarks were offered by Mr. R. A. Rolfe.—The next paper was one by Messrs. J. H. Lace and W. B. Hemsley on the vegetation of British Beluchistan, illustrated by a route-map showing the district in which Mr. Lace had been collecting. Seven hundred species were catalogued, amongst which were eleven new to science. The paper was ably criticized by Mr. C. B. Clarke, and Mr. J. G. Baker made some interesting observations on the peculiar prickly character of the vegetation which predominates in the hot and dry district explored.

Anthropological Institute, December 9.—Francis Galton, F.R.S., Vice-President, in the chair.—A paper on an apparent paradox in mental evolution, by the Hon. Lady Welby, was read.—Mr. Francis Galton, F.R.S., exhibited a large number of impressions of the bulbs of the thumb and fingers of human hands, showing the curves of the capillary ridges on the skin. These impressions are an unfailing mark of the identity of a person, since they do not vary from youth to age, and are different in different individuals. There is a statement that the Chinese—who seem to be credited with every new discovery—had used thumb impressions as proofs of identity for a long time; but Mr. Galton pronounced it to be an egregious error. Impressions of the thumb formed, indeed, a kind of oath or signature among the Chinese, but nothing more. Sir W. J. Herschell, however, when in the Civil Service of India, introduced the practice of imprinting finger-marks as a check on personation. Mr. Galton's impressions were taken from over 2000 persons by spreading a thin film of printers' ink on a plate of glass, then pressing the thumb or finger carefully on the plate to ink the papillary ridges, and afterwards printing the latter on a sheet of white paper. Typical forms can be discerned and traced, of which the individual forms are mere varieties. Wide departures from the typical form are very rare.

Mathematical Society, December 11.—Prof. Greenhill, F.R.S., President, in the chair.—The following communications were made:—On the reversion of partial differential expressions with two independent and two dependent variables, by E. B. Elliott.—Newton's classification of cubic curves, by W. W. R. Ball.—On the stability of a plane plate under thrusts in its own plane, with applications to the "buckling" of the sides of a ship, by G. H. Bryan (communicated by A. E. H. Love).—On the q-series derived from the elliptic and zeta functions of $\frac{1}{3}$K and $\frac{1}{4}$K, by Dr. Glaisher, F.R.S.—On the extension to matrices of any order of the quaternion symbols S and V, by Dr. Taber.—Steiner's poristic systems of spheres, by Prof. G. B. Mathews.

PARIS.

Academy of Sciences, Dec. 15.—M. Hermite in the chair.—The general relation of the state and increase of population, by M. Emile Levasseur. The relation is stated between the number of births, marriages, and deaths in France at different periods during this century. It appears that the proportion of suicidal deaths is increasing, although it is but 0·75 per cent. The illegitimate births amount to 7·5 per cent. in the period 1871-88, this proportion being about the mean illegitimacy of European nations. The number of male children born is known to be in excess of the number of female children; they become a minority, however, in the proportion of 57 to 61, because of the fact that the mean life of females is longer than that of men. All the statistics are graphically represented.—On the anomalous propagation of waves of sound, by M. Gouy.—On a modification of the electric gyroscope for the rectification of marine compasses, by M. G. Trouvé.—On the presence of very small quantities of aluminium in cast-iron and steel, by M. Adolphe Carnot.—On the increase of the number of red corpuscles in the blood of the inhabitants of the high plateaus of South America, by M. F. Viault.—On the development of the Copepodian parasite of Ascidiæ, by M. Eugène Canu.—On the localization of the active principle in the grain of Cruciferæ, by M. Léon Guignard.—On the structure of Peronosporæ, by M. L. Mangin.—Old observations of the vaccine tubercle of Leguminosæ, by M. Prillieux.—Synthesis of kainite and tachydrite, by M. A. de Schulten.—The depths of the Black Sea, by M. Venukof.

CONTENTS.

PAGE
The System of the Stars. By F. 169
Across Greenland 172

Our Book Shelf:—

David: "Les Microbes de la Bouche" 174
Aitchison: "Notes on the Products of Western Afghanistan and North-Eastern Persia."—**W. B. H.** 174
"Metal-Turning."—**N. J. L.** 175
"The Century Arithmetic" 175

Letters to the Editor:—

Biological Terminology.—**R. J. Harvey Gibson** . . 175
Streamers of White Vapour.—**N. F. Dupuis** . . . 175
On the Affinities of Hesperornis.—**Dr. R. W. Shufeldt** 176
A Swallow's Terrace.—**Robert H. Read** 176
Nests of the Red-backed Shrike.—**Robert H. Read** 176
"Fire-ball" Meteor of December 14.—**James Turle** 176
The Fossil Mammals of North America. (*Illustrated.*) By **R. L.** 177
Earthworms. By **S. N. C.** 179
Museums for Public Schools. By **Alexr. Meek** . . 180
James Croll, F.R.S. By **A. G.** 180
Notes 181

Our Astronomical Column:—

Stars with Peculiar Spectra 184
The Rotation of Jupiter 184
Eddie's Comet (?) 184
Names for Asteroids 184
Period of χ Cygni 184

Biological Notes:—

Illusion of Woodpeckers and Bears 184
Algæ Living in the Shells of Mollusks 185
The Australian Aborigines 185
Garden Scholarships 187
Washington Observations, Appendix I. 188
Field Experiments at Rothamsted 189
Scientific Serials 189
Societies and Academies 189